Tanta University
Faculty of engineering
Electrical Power and Machines engineering department
Principles of Energy Conversion Course

Sheet (1) ..... D.C. Generators

1) A 4 pole, lap wound, D.C. generator has 42 coils with 8 turns per coils. It is driven at 1120 r.p.m. If useful flux per pole is 21 mWb, calculate the generated e.m.f. Find the speed at which it is to be driven to generate the same e.m.f. as calculated above, with wave wound armature.

2) A 250 V, 10kW, separately excited generator has an induced e.m.f. of ~~225~~ 255 V at full-load. If the brush drop is 2 V per brush, calculate the armature resistance of the generator.

3) A short shunt compound D.C. generator supplies a current of 75 A at a voltage of 225 V. Calculate the generated voltage if the resistance of armature, shunt field and series windings are 0.04 Ω, 90 Ω and 0.02 Ω respectively.

4) A 4 pole, lap wound long shunt compound generator has 1200 armature conductor. The armature, series field and shunt field resistances are 0.1 Ω, 0.15 Ω and 250 Ω respectively. If the flux per pole is 0.075 Wb. Calculate the speed at which the machine should be driven so that it can deliver the load of 50 kW at 500 V. Take overall voltage drop due to brush contact as 2 V.

5) A wave wound, 6 poles, long shunt compound D.C. generator has 600 armature conductors. The generator is driven at 300 r.p.m. Calculate the e.m.f. generated if the flux/pole is 0.06 Wb. If now, the generator is required to produce e.m.f. of 550 V at a reduced value of flux/pole of 0.055 Wb, calculate the speed at which the armature of the generator must be driven.

Best wishes
Course committee:
Dr. Abd Al-Wahab Hasan
Eng. Mohamed Gamal
Eng. Kotb Mohamed

Tanta University
Faculty of engineering
Electrical Power and Machines engineering department
Principles of Energy Conversion Course

Model Answer of sheet (1) ..... D.C. Generators

1) Solution:

P = 4 $\quad \emptyset = 21\ mWb = 21\times10^{-3} Wb \quad$ N = 1120 r.p.m.

Coils = 42 $\quad$ turns/coil = 8

Total turns = coils × turns/coil = 42 × 8 = 336 turns

Z = 2 × total turns = 2 × 336 = 672 conductors

i) For lap wound, $\quad A = P$

$$E = \frac{\emptyset N Z}{60} = \frac{21\times10^{-3}\times1120\times672}{60} = 263.424\ V$$

ii) For wave wound, $\quad A = 2$

And $\quad E = 263.424\ V$

$$E = \frac{\emptyset P N Z}{120}$$

$$263.424 = \frac{21\times10^{-3}\times4\times N\times672}{120}$$

$$N = 560\ r.p.m.$$

السرعة قلت للنصف
مع اختلاف نوع اللف فقط

2) Solution:

Consider the separately excited generator shown in figure 1

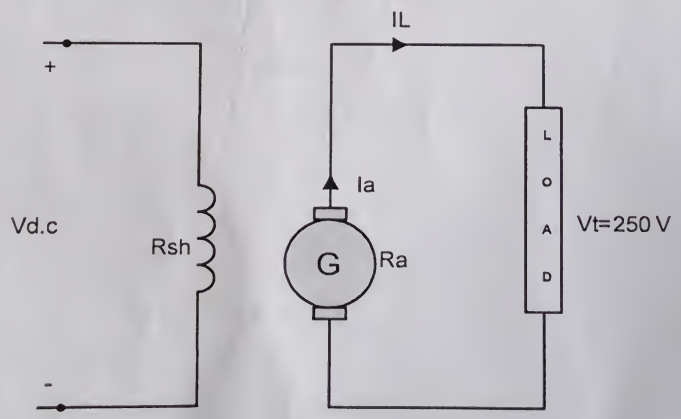

Figure 1

Note that 250 V, 10 KW generator means the full load capacity of generator is to supply 10 KW load at a terminal voltage $V_t = 250\ V$

$\therefore \quad V_t = 250\ V$ and $P = 10$ kw

And

$$P = V_t \times I_L$$

$$\therefore \quad I_L = \frac{10\times10^3}{250} = 40\ A$$

$\therefore \quad I_a = I_L = 40\ A$ .... as separately excited

Now: $E = V_t + I_a R_a + V_{brush}$

Now there are two brushes and brush drop is 2 V/ brush:

$\therefore \quad V_{brush} = 2 \times 2 = 4\ V$

$\therefore \quad E = 250 + 40 \times R_a + 4$

but $E = 255\ V$ on full load

$\therefore \quad 255 = 250 + 40\ R_a + 4$

$\therefore \quad R_a = 0.025\ \Omega$

3) Solution:

Consider a short shunt generator as shown in figure 2

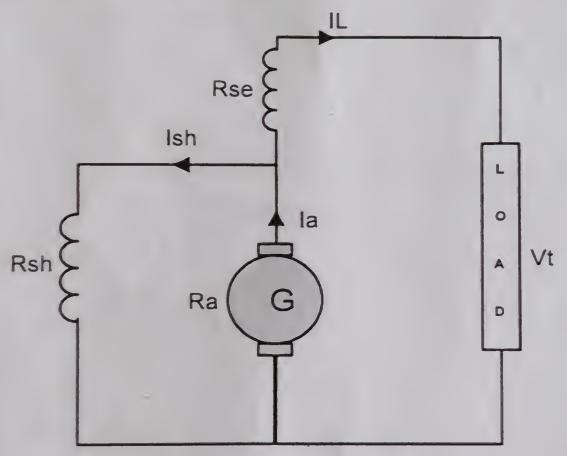

Figure 2

$R_a = 0.04\ \Omega$ $R_{sh} = 90\ \Omega$ $R_{se} = 0.02\ \Omega$

$V_t = 225\ V$

$I_L = 75\ A$

$I_a = I_L + I_{sh}$

Now: $E = V_t + I_a R_a + I_L R_{se}$

And drop across armature terminals is:

$$E - I_a R_a = V_t + I_L R_{se} = 225 + 75 \times 0.02 = 226.5\ V$$

$$\therefore \quad I_{sh} = \frac{E - I_a R_a}{R_{sh}} = \frac{V_t + I_L R_{se}}{R_{sh}} = \frac{226.5}{90} = 2.5167\ A$$

$$\therefore \quad I_a = I_L + I_{sh} = 75 + 2.5167 = 77.5167\ A$$

$$\therefore \quad E = V_t + I_a R_a + I_L R_{se} = 225 + 77.5167 \times 0.04 + 75 \times 0.02$$

$$= 229.6\ V$$

4) Solution:

$P = 4$, $A = P = 4$ as lap winding.

$Z = 1200$, $\emptyset = 0.075$ Wb

$P = 50$ kW, $V_t = 500$ V, $V_{brush} = 2$ V

$R_a = 0.1\ \Omega$, $R_{se} = 0.15\ \Omega$, $R_{sh} = 250\ \Omega$.

Considering a long shunt generator as shown in figure 3

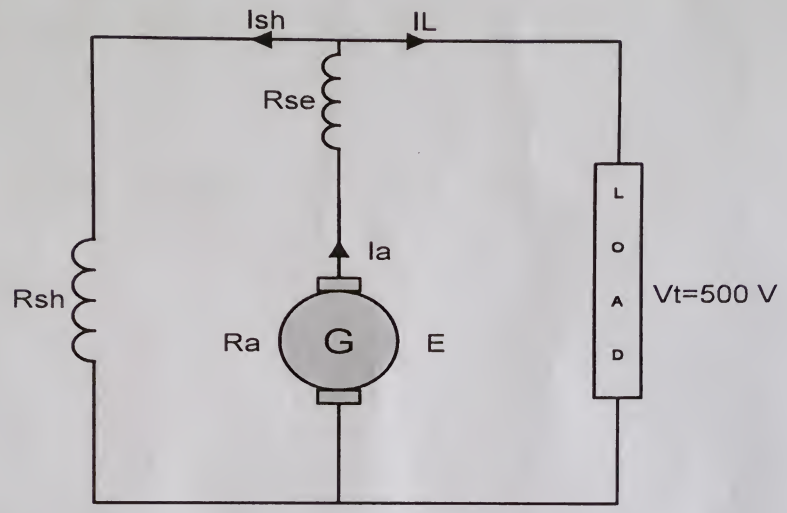

Figure 3

$I_a = I_L + I_{sh}$

$$I_{sh} = \frac{V_t}{R_{sh}} = \frac{500}{250} = 2A$$

$P = V_t \times I_L$

$50 \times 10^3 = 500 \times I_L$

$I_L = 100$ A

$I_a = I_{sh} + I_L = 102$ A

Now $E = V_t + I_a R_a + I_a R_{se} + V_{brush}$

$= 500 + 102 \times 0.1 + 102 \times 0.15 + 2$

$= 527.5$ V

$$E = \frac{\emptyset P N Z}{60 A}$$

$$527.5 = \frac{0.075 \times 4 \times N \times 1200}{60 \times 4}$$

$N = 351.67$ r.p.m.

5) Solution:

P = 6, Z = 600, N_1 = 300 r.p.m., $\emptyset_1$ = 0.06 Wb, wave wound

For N_1 = 300 r.p.m. the e.m.f. generated is,

$$E_{g1} = \frac{\phi_1 P N_1 Z}{60A} \quad \text{..... A = 2 for wave}$$

$$= \frac{0.06 \times 6 \times 300 \times 600}{60A} = 540V$$

New values of flux $\emptyset_2$ = 0.055 Wb and E_{g2} = 550 V

$$E_{g2} = \frac{\phi_2 P N_2 Z}{60A}$$

$$550 = \frac{0.055 \times 6 \times N_2 \times 600}{60 \times 2}$$

N_2 = 333.33 r.p.m.

Best wishes

Course committee:

Dr. Abd Al-Wahab Hasan

Eng. Mohamed Gamal

Eng. Kotb Mohamed